
LANL Heavy Ion Program Overview

Melynda Brooks
Physics Division, Los Alamos National Laboratory

Outline (this talk):

- Physics Program Overview
- Personnel, Group Efforts, Funding Sources
- Scientific Roles
- Introduction to Accomplishments and Future Program
- Support Requested

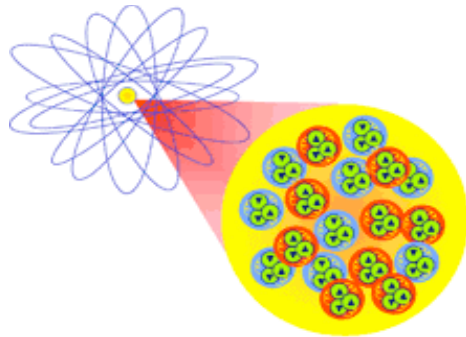
Mike Leitch - Cold Nuclear Matter, QGP Screening and Regeneration

Gerd Kunde - Understanding Energy Loss in the QGP

Melynda Brooks - Resources, Budget, Wrap-up

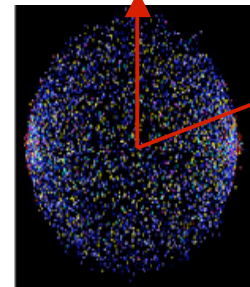
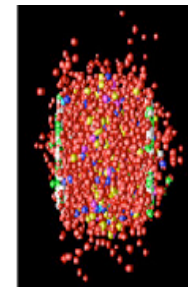
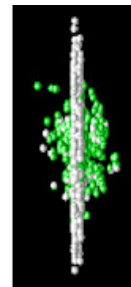
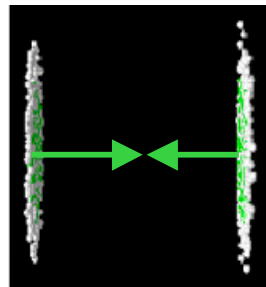
LANL Heavy Ion Physics Program

Physics Program: Extracting properties of Quark Gluon Plasma medium through systematic study of p+p, d+A, A+A collisions, using a variety of probes



Cold Nuclear Matter

Hot Nuclear Matter

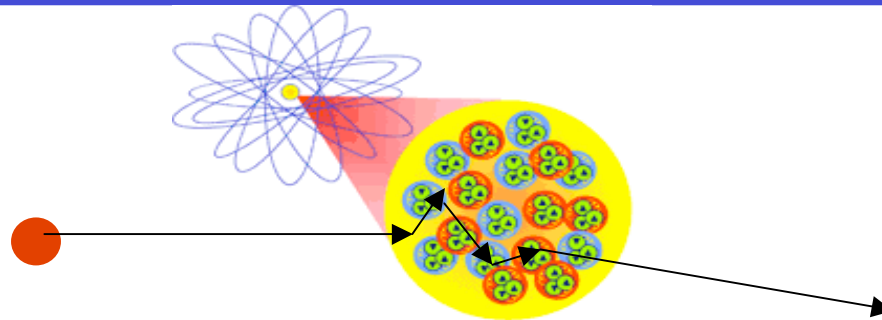


Extracting QGP properties from A+A collisions requires understanding of:

- Superposition of nucleon-nucleon collisions plus:
- Are quark/gluon distributions different inside a nucleus?
- Does multiple scattering, energy loss of incoming partons traversing a nucleus significantly modify particle production? Absorption in nucleus?
- How do these interactions, extracted from d+A, extrapolate to A+A?
- Finally, how does the high density medium affect particle production:
 - Energy loss of the partons in the high density medium
 - Is formation altered because of medium: particles screened, or broken up and reformed?
 - What role does recombination play in particle production?

Unraveling Cold Nuclear Matter Effects

Cold Nuclear Matter Program: Understanding QCD dynamics in nuclei;
Measuring d+A and extrapolating to A+A

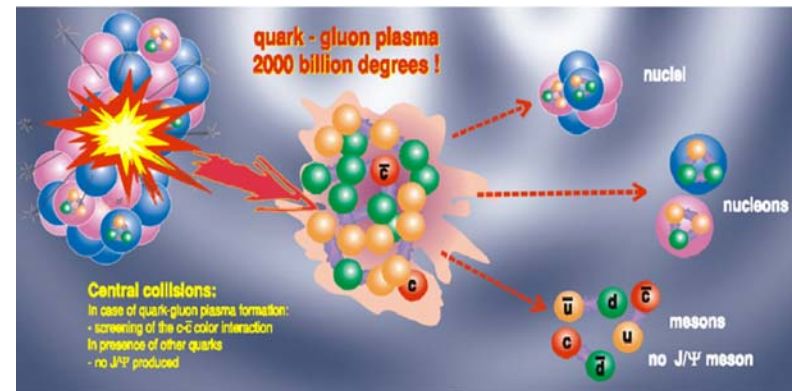
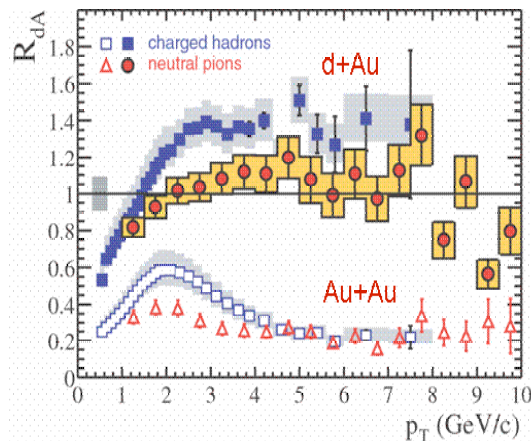


- Multiple scattering flattens p_T distributions
- Energy loss effectively shifts beam energy, producing fewer particles, especially at low x
- Shadowing depletes low x gluons(quarks), enhances high x --> smaller production at low x , higher at high x
- Relative contributions of shadowing, energy loss change versus beam energy
- Quarks and gluons have different magnitude effects
- Final-state absorption differs for different produced particles

Measurements versus p_T , x , beam energy, with different probes allows unraveling of different Cold Nuclear Matter components

Physics Program - Heavy Ions Then

Simple picture of QGP mostly supported by early RHIC data.



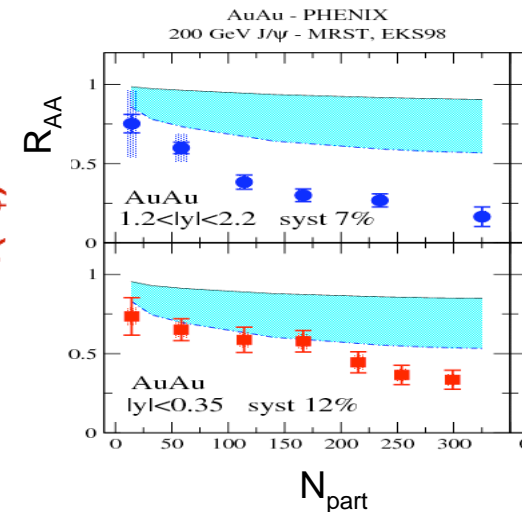
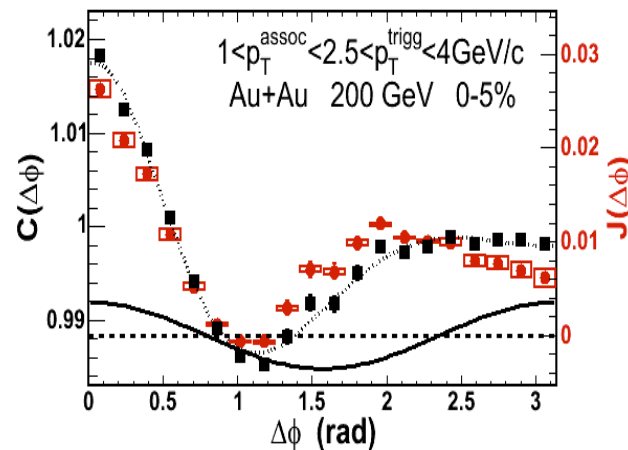
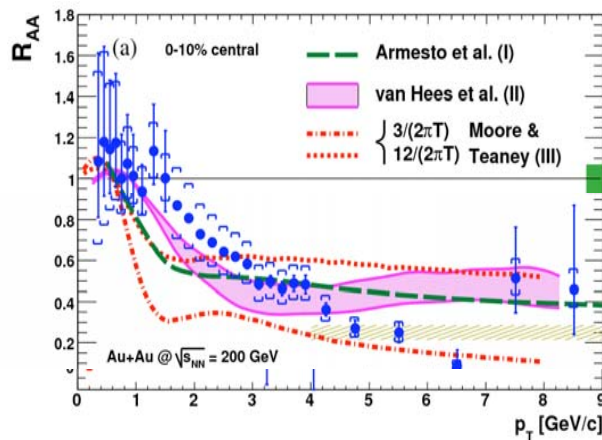
QGP Picture after first RHIC data

- Pions heavily suppressed, as expected --> interpreted as radiative energy loss, gluon density in the medium inferred
- Heavy mesons expected to be much less suppressed
- Hadron-hadron correlations expected to see broadened, suppressed away-side peak
- Vector mesons expected to be suppressed more than SPS
- Vector mesons expected to be suppressed more at central rapidity than forward rapidity

Physics Program - Heavy Ions Now

Puzzles: light/heavy quark suppression, jet modification, screening like SPS

- Compare heavy and light flavor modifications to understand energy loss mechanisms in the medium.
- Use jet-correlation measurements to study in detail how hadrons propagate through the medium.
- Use vector meson measurements to measure screening contributions, recombination



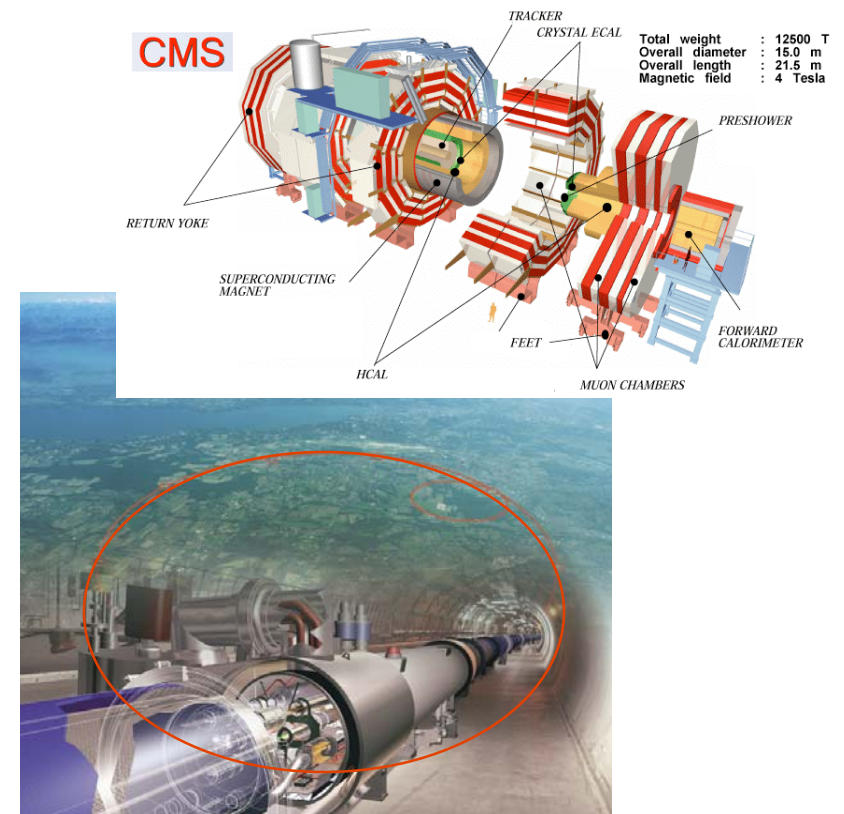
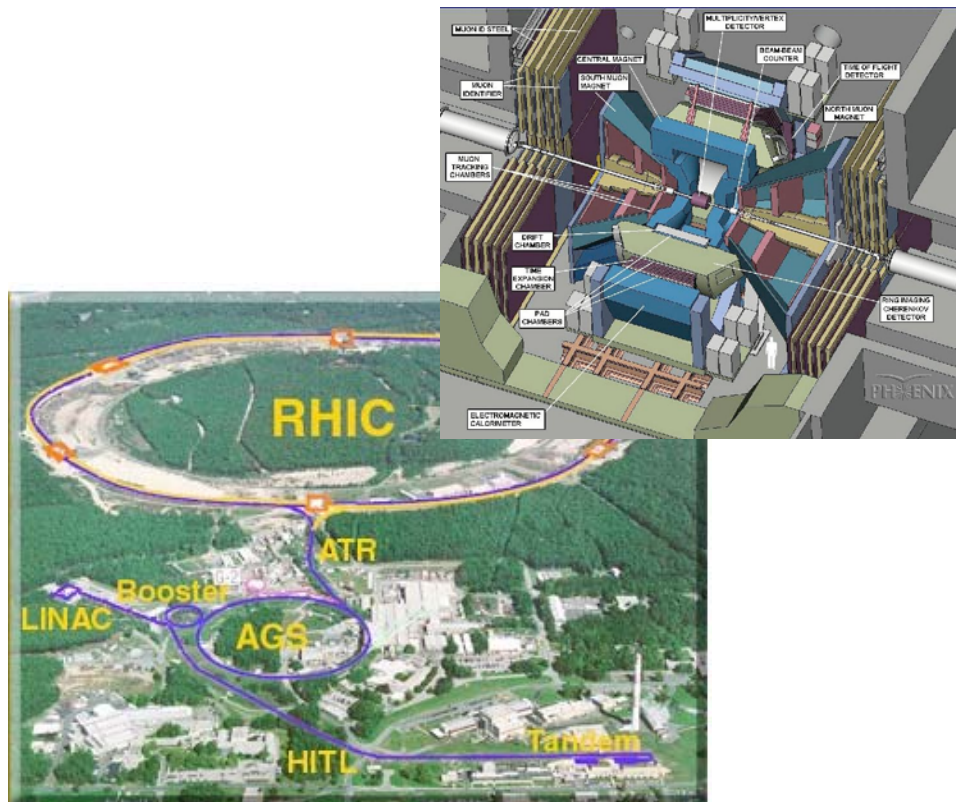
LANL Proposed Program: Precision heavy flavor measurements, better jet tomography, more vector meson measurements

Chosen Tools at RHIC, FNAL, LHC

PHENIX Detector at RHIC - comprehensive p+p, d+A, A+A program to study light and heavy quark production, vector meson production

CMS Detector at LHC - high energy gives unique access to hard probes, jet tomography

FNAL E906 - unique access to unambiguous CNM energy loss

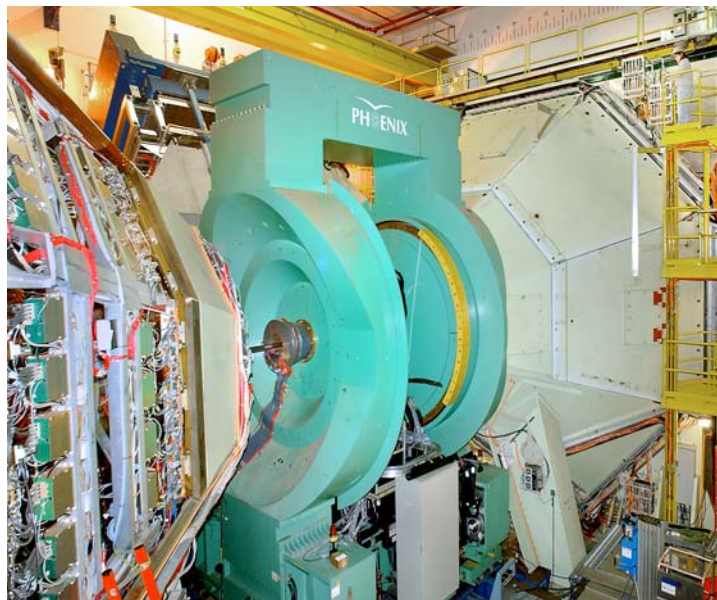


LANL Contributed PHENIX Muon Trackers

Muon Tracker Contributions - Designed, built, installed, commissioned muon tracker systems.

Current Responsibilities - DC Member, provide several on-call expert shifts per run, coordinate and perform maintenance each shut down, working closely with Muon Trigger upgrade

Muon Tracker Analyses - Have provided much of the simulation and reconstruction software, as well as online QA software for the Muon Trackers. Lead roles in most muon physics analyses (sustained staff, post-doc effort required for maintenance of detectors)



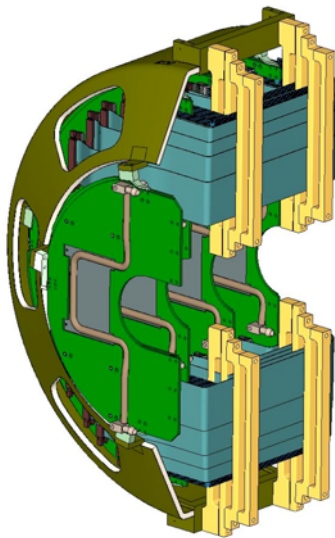
Silicon Trackers Enhance RHIC Physics Program

FVTX/iFVTX - significantly enhancing the Muon Physics program with precision tracking

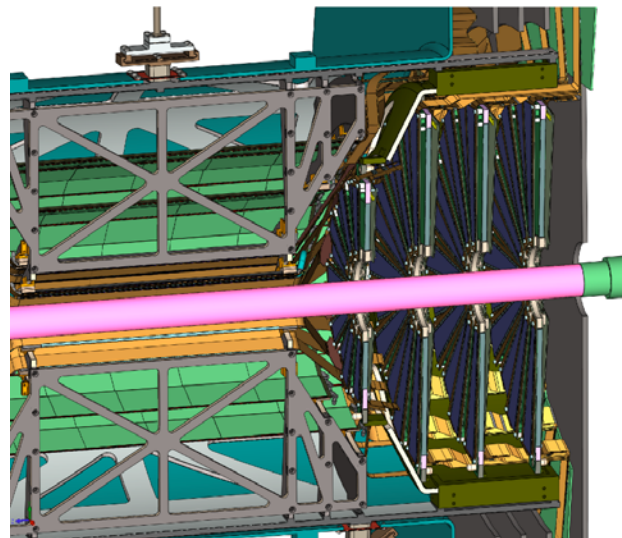
Physics Measurements - precision open heavy flavor measurements, flavor-separation, significantly improved vector meson program

LDRD funds - significantly advance R&D, theory, allows early data taking

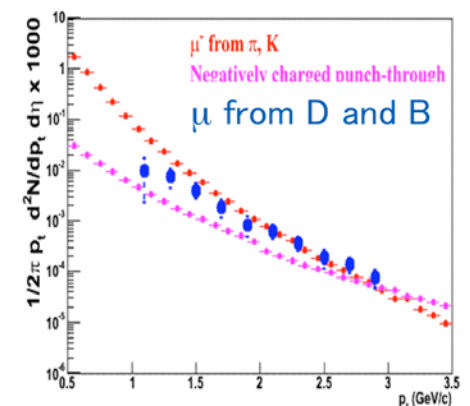
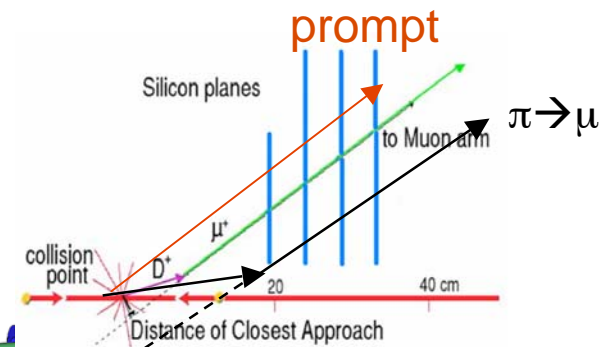
LANL Role - Project Leaders, DAQ, sensor and readout chip, software



LDRD: R&D, Early Data,
Theory



Initiated + Leading FVTX Effort



Personnel Contributing to Heavy Ion Program

Technical Staff Members (4.1 FTEs on KB02 in FY08):

Melynda Brooks, Xiaodong Jiang, **Jon Kapustinsky**, **Gerd Kunde**, **David Lee**, **Mike Leitch**, Ming-Xiong Liu, **Pat McGaughey**, **Walt Sondheim**, **Hubert vanHecke**

LDRD-supported Staff:

above, plus Gary Grim (P-23), Mark Prokop (AOT), electrical designers

Post-Docs (2 FTEs on KB02 in FY08) :

Sergey Butsyk, **Lei Guo**, Camelia Mironov, **Zhengyun You**, Han Liu, (**Paul Constantin**, **Carlos Camacho**, Anuj Purwar recently departed post-docs)

Students and Full-Time Visitors:

Maria Castro, Hisham Albataineh (NMSU), Xiaorong Wang (NMSU), Zhengyun You (Peking), Michael Malik (UNM)

NSF REU Students:

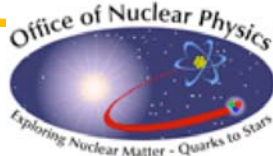
Samuel Fletcher, Michelle Adan

***Bold-face indicates primary contributors to KB02 work**

Some Key Roles

PHENIX Physics Working Group Convenors: Brooks (past), Leitch (current)
PHENIX Executive Council: Leitch
PHENIX Single Muon Working Group Convenor: Liu
PHENIX Paper writing committees: all
PHENIX Run coordinator: Leitch (run07, run08)
PHENIX Period coordinators: Butsyk, Leitch, Liu
FVTX Project Managers: Brooks, Lee
VTX Mechanical Liaison: Lee
Integration & Engineering, VTX/FVTX Mechanical Lead Engineer: Sondheim
PHENIX Detector Council Members: Brooks (past muon), van Hecke (past MVD),
Leitch (current muon)
PHENIX Subsystem manager: Lee (Muon Tracker Mechanical)
PHENIX Physics Impact Panel for QM05 – Leitch
Co-Convenor of RHIC II pA/Forward physics group – Leitch
NSAC Long Range Planning Committee: Lee
APS Hadron Physics Topical Group Executive Member - Leitch (past)

Funds Supporting PHENIX Team Efforts



DOE Supported Efforts

Heavy Ion Physics - RHIC Heavy Ions and Cold Nuclear Matter \$2280k/FY08
FVTX (LDRD covered R&D efforts, construction funding beginning)
VTX (construction funds for Walt Sondheim, physicist support from Dave Lee)
PHENIX Muon Tracker - continued maintenance, expert shifts, etc.

Medium Energy Physics - Proton Spin and Cold Nuclear Matter studies at RHIC,
 (JLAB) - \$949k/FY08



LDRD-Supported Efforts

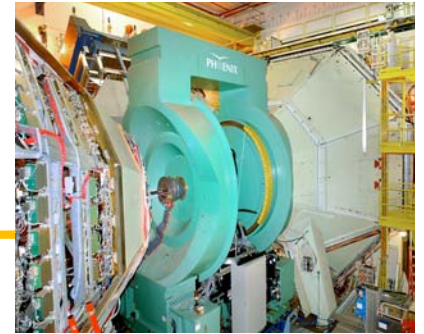
Heavy Quarks as a New Probe of the Quark Gluon Plasma (iFVTX) - \$1700k/year
 2006-2008 (following LDRD ER 2003-2005)
Heavy Ion Physics at the LHC using CMS - 2006-2008 \$250k/year
The First Precise Determination of Quark Energy Loss in Nuclei (FNAL E906)
 2008-2010 \$250k/year
Discovery Physics at the Large Hadron Collider - proposed FY09-FY11 \$1300k/year



Melynda Brooks, LANL



Some Past Accomplishments



Recent Highlights

- Led J/ψ , hadron and open heavy flavor studies at forward rapidity in d+Au and Au+Au collisions
- Advanced jet-modification understanding using hadron-hadron correlations
- First open heavy flavor measurement via $D \rightarrow K\pi\pi$
- Developed Z^0 -tagged jet experiment using CMS detector
- Provided, and maintain, PHENIX Muon Tracking systems
- Significant contributions to Muon Analysis software
- Leading Forward Silicon Vertex Tracker (FVTX) effort

Unique LANL Contributions

- Significant LANL LDRD support to advance new studies at RHIC, LHC and FNAL
- Host of several students, post-docs and research staff at LANL
- Organizers of several physics and technical workshops
- Significant technical resources available
- Close collaborations with Theory-Division
- Contributions to other missions within the laboratory, outreach activities

Proposed 4-year Program

RHIC Analyses

- Advance vector meson analyses, precision open heavy flavor analyses, hadron-hadron correlations, from d+A and A+A

RHIC Hardware Efforts

- Continued maintenance of Muon Tracker Systems
- Continue leading FVTX efforts

LHC Analyses

- Z^0 -tagged jet analysis, heavy-flavor jet analyses

LANL-funded (LDRD) Efforts

- Continued LHC studies (current, plus proposed LDRD)
- Cold nuclear matter energy loss using FNAL E906

Requested KB02 funds

- \$2280k (FY08), \$2498k (FY09), \$2718k (FY10), \$2813k (FY11)
- Current budget, President's budget, 9% increase, inflation

Break for Mike/Gerd's Talks

LANL Heavy Ion Program Resources, Budget

Melynda Brooks
Physics Division, Los Alamos National Laboratory

Outline:

- Milestone reminder
- Where resources are required
- Resource Allocations/Year, Budget

Milestones

- **Analyze** new forward rapidity J/ψ and heavy flavor via single muon data from **RHIC Run 8**.
- **Extract the cold nuclear matter contributions** of shadowing, absorption, and energy loss using the above measurements.
- **Expand and improve the vector meson measurements** that can be made with the PHENIX muon arms. Both ψ' and upsilon measurements will be pursued with the current detector and with the detector plus the FVTX upgrade detector.
- Continue to pursue the reconstruction of **$D \rightarrow K\pi\pi$** using the PHENIX central arm detectors.
- Use LDRD funds to pursue unambiguous cold nuclear matter energy loss measurement using **FNAL E906**.
- Lead the efforts to **construct and install** into PHENIX a new **forward silicon vertex detector**.
- **Analyze first data from the iFVTX/FVTX detectors** and muon arms, to get first precision forward rapidity open heavy flavor measurements from RHIC.
- Analyze improved vector meson data using the FVTX detector and muon arms.
- **Analyze** first p+p and heavy ion data from the CMS detector at the LHC, aiming to look specifically for Z^0 -tagged and heavy quark-tagged jet events.
- **Map jet shapes for p+p and Pb+Pb at CMS**, both as a function of the cone radius and the transverse momentum distribution of particles, and compare with theory.
- **Co-lead the effort to construct and install a pixel luminosity telescope for CMS** (proposed LDRD, P-23 personnel included)

Efforts Guiding Resource/Budget Request

Significant new FVTX Construction Effort (FY08-FY10/11), followed by new analysis efforts

We feel it is vital to maintain RHIC analysis effort during this construction

We have significant (LANL) investments in LHC heavy ion program and now is the time to join CMS. We hope to do this supported by LDRD, but in the absence of LDRD we propose that DOE provide modest support for the program to bring new HI data to the program

We propose to maintain commitment to PHENIX Muon Tracking systems

- FY09, FY10 increases necessary to fulfill our FVTX construction commitments and at the same time maintain healthy RHIC and LHC analysis efforts
- In FY11 construction project efforts fulfilled. The FY09/FY10 analysis efforts at RHIC/LHC can be ramped up to take full advantage of FVTX and LHC heavy ion program
- We hope we can call on fellow PHENIX collaborators to help more with MuTr maintenance during crunch years (FY09, FY10).

Requested KB02 Support, No LHC LDRD

	FY08 (TSM + PD)	FY09 (TSM + PD)	FY10 (TSM + PD)	FY11 (TSM + PD)
RHIC Analyses	2.35 + 1.5	2.0 + 0.75	2.0 + 0.75	3.0 + 1.4
FVTX*	1.5 + 0.4 (plus LDRD)	1.7 + 1.0	1.9 + 1.0	0.25 + 0.1
MuTr Maint.	0.25 + 0.1	0.15 + 0.0	0.15 + 0.1	0.25 + 0.1
LHC Analyses	0.5 + 1.0 (LDRD)	0.5 + 0.5	0.5 + 0.5	1.0 + 0.9
Total Staff	4.1 + 2.0	4.35 + 2.25	4.55 + 2.35	4.5 + 2.5
Total Funds	\$2280k	\$2498k	\$2718k	\$2813k

*FVTX will have additional effort supported by KB01, construction

Efforts Redistributed if We Get LHC LDRD

	FY08 (TSM + PD)	FY09 (TSM + PD)	FY10 (TSM + PD)	FY11 (TSM + PD)	
RHIC Analyses	2.35 + 1.5	2.0 + 0.75 2.4 + 1.1	2.0 + 0.75 2.4 + 1.0	3.0 + 1.4 3.5 + 1.9	← Increased
FVTX*	1.5 + 0.4 (plus LDRD)	1.7 + 1.0	1.9 + 1.0	0.25 + 0.1	
MuTr Maint.	0.25 + 0.1	0.15 + 0.0 0.25 + 0.1	0.15 + 0.1 0.25 + 0.15	0.25 + 0.1 0.25 + 0.1	← Increased
LHC Analyses	0.5 + 1.0 (LDRD)	1.8 + 1.0	1.8 + 1.0	2.3 + 1.4	← No DOE Required
Total Staff	4.1 + 2.0	4.35 + 2.25	4.55 + 2.35	4.5 + 2.5	
Total Funds	\$2280k	\$2498k	\$2718k	\$2813k	

*FVTX will have additional effort supported by KB01, construction